Competition Systems

CSI400

ProTune
User's Manual
with
Quick Start

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Introduction

What you've bought

This document provides an overview of the basic features and functions of the CSI 400 ProTune data-recording dash. The CSI 400 itself is housed in a water-proof, 7¼x3½x1" metal case with a large, easy to read LCD display and a single row of eight buttons. The LCD features two large numeric displays, four bar graphs, and various units labels that identify the values on the numeric displays.

What to read (Quick start, mostly).

As the heading says, even if you read nothing else in this manual, please read Quick Start. It provides a step-by-step procedure to verify that your new data recorder is functioning. It also leads you through the steps to enter the information necessary to let your dashboard properly interpret the signals coming from your sled. Finally, it leads you through a very brief tour of the functions of the ProTune.

About this manual.

The Quick Start chapter is intended as the one part of this manual that absolutely **must be read** before using the ProTune. The rest of this document will sit quite contentedly on a shelf until it is needed as a reference.

Warranty

The ProTune data recording dash is warranted to be free from defects in materials and workmanship for a period of one year. The sole remedy shall be repair or replacement (at CSI's discretion) of the defective unit. Under no cirumstances does Competitions Systems warrant the vehicle to which the ProTune is attached.

The temperature probes provided with the ProTune are warranted for two years by Exhaust Gas Technologies. EGT can be reached at (800) 348-4678.

Customer Service

If you have questions about your ProTune and are unable to find answers in this manual, please contact the company that supplied the unit. If they are unable to answer the questions, CSI can be reached at (714) 580-6894. FAXes may be sent to (714) 580-6897.

Quick Start

This chapter provides step-by-step instructions for the installation and configuration of the CSI 400 ProTune recording dashboard. In-depth explanations of the various options can be found in later chapters.

Installation

Please see Appendix A: Installation Guide on page 37.

Preliminary Setup and Hardware Verification

Once the hardware has been installed, check all cabling and start the sled.

Press the ProTune's ON/OFF button. The LCD should flash twice before showing RPM 1 on the left-hand display and MAX EGT on the right-hand display.

```
1 RPM/10      MAX  EGT ?
????     1234    ????
```

The RPM may be from 2 to 8 times too high. Note this number. For example, if the unit reads 4016 with the engine at 1004 RPM, write down that the RPM is 4 times too high. The next section explains how to use this error factor to correct the reading.

Check that the indicated RPM goes up when the engine speed increases.

Each press of the DISPLAY button should show a new User Display. Verify that all optional data channels are present by pressing DISPLAY until the LCD returns to RPM 1 and MAX EGT.

```
EGT  1        EGT  2
????     1234    ????
```

Press DISPLAY to view EGTs 1 and 2. Verify that the temperatures are stable and show reasonable numbers. If the ProTune unit has extra EGT channels, press DISPLAY and check them as well.

```
   1            2
 ?.??    1234   ?.??
```

If the unit has optional Analog channels, press DISPLAY to view them. Check that the voltages are reasonable and stable.

Press ON/OFF. The computer should turn off.

Press ON/OFF and verify that the optional warning light blinks twice with the LCD as the unit powers up.

Software Configuration

The left-hand column diagrams the way the LCD should look if the unit starts in the factory preset condition. To perform a *master clear*, which erases all user entries and returns the ProTune to the factory presets, turn the unit off. Hold the CLEAR and ON/OFF buttons until the display stops flashing. This power-on sequence **erases all user entries** and returns the unit to the factory presets. Press PLAYBK to end master clear mode.

Do not perform a master clear if the unit contains setup information that should be retained.

Note
Any step printed in a dark box configures optional equipment and does not appear on the basic ProTune.

Press SETUP to enter Setup mode.

Except where otherwise noted, press SETUP to store an entry or press PLAYBK to store the entry and exit Setup mode.

1 RPM P1 1	Press STEP ⇒ (also labeled BKLIGHT) until the flashing number matches the RPM error factor from the Verification step. Press SETUP to store.
2 RPM P2 1	If the LCD shows RPM 2, press STEP ⇒ to set the number of pulses the jack shaft generates each revolution. This value is probably the same as the number of magnets on the jack shaft.
RAT FAc 1.00	Set the constant factor for the ratio of RPM 1 to RPM 2. This number should be the gear reduction ratio between the engine and the clutch input shaft.
3 RPM P3 1	If RPM 3 will be used as a timer, disregard the number of pulses per revolution. Otherwise, press STEP ⇒ to set the number of pulses generated per revolution.
TIM OFF TIM On ???	Press STEP ⇒ to set the timer to desired type. <u>OFF</u> uses RPM3 as an RPM channel. <u>On inc</u> sets the timer to record the intervals between pulses and might be used as a lap timer. <u>On Acc</u> records the elapsed time since the first pulse and could be used to determine the times to certain distance markers in a drag racing run.
RPM/10 L1 1000	Use STEP ⇐ and STEP ⇒ to set the RPM 1 overlimit level. If RPM1 exceeds this number, the display will flash and the optional warning light will come on. Remember that 1000 $^{RPM/10}$ means 1000×10 or 10,000 RPM. As always, press SETUP to store.
EGT 1 L2 1450	Use STEP ⇐ and STEP ⇒ to set the EGT 1 overlimit level in degrees F. Press SETUP to store.
EGT 2 L3 1450	Use STEP ⇐ and STEP ⇒ to set the EGT 2 overlimit level in degrees F. Press SETUP to store.
EGT 3 L4 1450	Use STEP ⇐ and STEP ⇒ to set the EGT 3 overlimit level in degrees F. Press SETUP to store.

EGT 4 L5 1450	Use STEP $\Leftarrow$ and STEP $\Rightarrow$ to set the EGT 4 overlimit level in degrees F. Press SETUP to store.
1 L6 5.00	Use STEP $\Leftarrow$ and STEP $\Rightarrow$ to set the overlimit level for optional analog channel 1. Press SETUP to store.
2 L7 5.00	Use STEP $\Leftarrow$ and STEP $\Rightarrow$ to set the overlimit level for optional analog channel 2. Press SETUP to store.
3 L8 5.00	Use STEP $\Leftarrow$ and STEP $\Rightarrow$ to set the overlimit level for optional analog channel 3. Press SETUP to store.
4 L9 5.00	Use STEP $\Leftarrow$ and STEP $\Rightarrow$ to set the overlimit level for optional analog channel 4. Press SETUP to store.
1 RPM MAX EGT d0 1 6	This screen configures the User Displays. Press PLAYBK to skip to bar graph setup. For more details, see the **Setup** chapter. **Do not press SETUP** after pressing PLAYBK.
EGT 1234 Lo $_{1234}$ 0	Press SETUP to leave the temperature value of the bottom bar of the EGT bar graphs at 0°F.
EGT 1234 inc $_{1234}$ 100	Press SETUP to leave each bar graph segment at 100°F. Segment 1 is always on. Two segments now indicates 200-299°F. All fourteen segments indicates more than 1400° F.
TIM OFF 10	Use STEP $\Leftarrow$ and STEP $\Rightarrow$ to set the number of minutes the ProTune will wait before automatically shutting itself off when running only on the optional internal battery. Press SETUP to store the value.
M 123X inP SA$\cup$ inP rEc	Use STEP $\Rightarrow$ to set the ProTune to treat the optional remote switch as a STORE press (<u>SA</u>v) or as a RECORD press (<u>rEc</u>). Press SETUP to save.
MPH CAL 660	Use STEP $\Leftarrow$ and STEP $\Rightarrow$ to set the number of RPM 2 pulses in 660' (one eighth of a mile). Alternatively, press RECORD and drive 660'. The ProTune unit counts the pulses as the tread rotates. Since the CAL value is used to calculate MPH and distance traveled, any tread slip will affect those readings. Press SETUP to complete configuration and return to Run mode.

Performing a Sample Run

Start the sled. Return the ProTune to Run mode by turning the unit off and then on again. The display should show

1 RPM/10   MAX EGT ?
????   _1234_   ????

Press DISPLAY several times to become familiar with the various display modes.

Playing the VCR Tape

Press PLAYBK. The display returns to ^{1} ^{RPM} and ^{MAX} ^{EGT} and the VCR mode box ( ) turns on. The buttons now respond as the lower row of labels indicate.

Press PLAY and watch the RPM and EGTs play back the stored run. Note the flashing arrow, which indicates that the data is read from the tape. (**Important: There is no real tape.** The data is stored in solid-state computer chips inside the unit.)

If the unit does not display data, press PLAYBK then ON/OFF to turn the unit off. Press ON, then PLAYBK to return to VCR mode.

1 RPM/10   MAX EGT 3
139   _1234_   480

There is a 12 second drag run stored on the VCR tape when the unit is powered up. The first frame should look like the figure shown at left.

Press REWIND to return to the start of the tape. Press PLAY again to start playback. Press STOP while the tape is running. Press STEP $\Leftarrow$ and STEP $\Rightarrow$ to view the recording one frame at a time.

Recording Data

Press DISPLAY to view channels other than RPM 1 and MAX EGT.

Press RECORD. Notice that the VCR mode box vanishes but the flashing arrow remains. The ProTune is now in Run mode while it records the sled's behavior. The arrow will flash for 25 seconds, the length of the tape, before disappearing.

Once the arrow stops flashing, press PLAYBK to return to VCR mode. Look for the VCR mode box. The display now shows the first frame of the VCR tape. The left-hand number is the sled's RPM at the start of the recording.

Press PLAY to run the tape. Press DISPLAY to view the other channels' behavior during the recording.

Notice the ^{TIM} ^{2} display. ^{TIM} ^{2} shows the number of seconds since the start of the tape.

The arrow flashes in the VCR box until the tape ends or STOP is pressed.

Press RECORD and drive the sled for 30 seconds. Stop and press PLAYBK to return to VCR mode. Press PLAY to view the behavior of the sled during the recorded period.

Press RUN to return to Run mode. The VCR mode box should disappear.

Working with Snapshot Data

Press RECALL. The LCD now flashes ^{M} ^{X} over the left-hand number to show that the values displayed are the stored peak values. Press DISPLAY and look at the peak for each channel. Return the display to RPM 1 and MAX EGT.

Press RECALL again. LCD flashes ^{M} ^{1} instead of ^{M} ^{MAX} and the RPM and MAX EGT drop to zero. This is the first of the three stored snapshots. Since no snapshots have been saved with the STORE button, all channels read 0.

Press RECALL twice more to return to Run mode. The ^{M} ^{123} indicators no longer flash and the numeric displays now show the sled's current status.

Rev the sled's engine and press STORE while the RPMs are up. Let the engine return to idle.

Press RECALL to view the MAX snapshot. The RPM shown is the peak rev the sled reached. Press DISPLAY to view the other channels' peak values. Press DISPLAY until the LCD shows RPM and MAX EGT.

Press RECALL to view the first stored snapshot. The RPM, with blinking ^{M} ^{1} indicator, should now show the RPM and MAX EGT as they were when the STORE button was pressed.

Press RECALL again. The ^{M} ^{2} indicator blinks and the values drop to 0. There is only one stored snapshot.

Press CLEAR to erase all stored snapshots and return to Run mode.

Press PLAYBK. The run recorded earlier should still be in memory. CLEAR has no effect on the VCR tape. The tape is retained in memory until the unit is turned off or a new run is recorded.

Press PLAYBK to return to Run mode. Press ON/OFF to turn the unit off.

For more detailed information on any of the features of the ProTune, please see the appropriate section of the documentation.

Basic Operation

Switching on the CSI 400 ProTune

Press the ON/OFF button and hold it until the LCD flashes. The display flashes twice and the unit enters Run mode.

The ProTune has two distinct operating modes: Run, used to acquire data, and PlayBk or VCR, used to review previously stored data. There is also a third mode, Setup, which is used to customize the ProTune. The Run and PlayBk modes are described below. Setup mode is described in a separate chapter.

Making Sense of the ProTune

The Display

The LCD consists of four 14 segment bar graphs and two 1" tall, 3½ digit numeric displays. Each of the numeric displays has several smaller indicators which identify the units and the channel of the value currently shown. The channels that the ProTune can display are listed below:

RPMs are identified by 1-3 and RPM/10 and are displayed in units of RPM divided by 10.

2 RPM/10
857   indicates 8570 RPM on RPM channel 2.

Temperatures are identified as EGT and a channel number and are displayed in degrees Fahrenheit. By default, the bar graphs always display the EGTs.

EGT 3
1354   indicates 1354° F on temperature channel 3.

The maximum EGT is displayed as MAX EGT.

MAX EGT 1
1938   indicates that temperature 1 is currently the highest EGT at 1938° F. If EGT 3
MAX EGT 3   climbed to 1970°, the LCD would display
1970   to reflect the change.

Analog to Digital channels are identified by channel number only and are displayed in Volts, degrees F, PSI, or Gs. The units are set at the factory to match the sensor.

4
2.42   indicates 2.42 Volts on A/D channel 4, assuming channel 4 is factory-set to display raw Volts.

Elapsed time is identified as TIM and uses both numeric displays. The left-hand number holds minutes and seconds. The right-hand number shows thousandths of a second.

TIM
4.23 : 235   indicates an elapsed time of 4 minutes, 23.235 sec.

Elapsed time can also be displayed in abbreviated form on the left-hand display as TIM 3.

TIM 3
137.3   indicates an elapsed time of 137.3 seconds.

Frame index time is identified as TIM 2 and is displayed in seconds.

TIM 2
23.4   indicates that the VCR tape is currently at the frame 23.4 seconds into the run.

Miles per hour is identified as "MPH".

MPH
65.3   indicates that the sled speed, as calculated from the tread speed, is 65.3 miles per hour.

The adjusted ratio of RPM1 to RPM2 is identified as "RAT".

RAT
1.52   indicates that RPM 1 is 1.52 times higher than (RPM 2 $\times$ RAT FAc). See Setting the RPM 2 Ratio Factor on page 29.

Total distance traveled is displayed in miles and is identified as "M". In VCR mode this value is labeled "X" and shows feet traveled since the start of the tape. Both of these values are computed from RPM2 and will be affected by tread slip.

M
19.5   indicates that the sled has traveled 19.5 miles since the ProTune was CLEARed.

X
1621   indicates that the sled has traveled 1621 feet since the start of the VCR tape.

__The Bar Graphs__

The LCD has four bar graphs to provide information at a glance. The factory sets each of these graphs to present the reading from one of the EGT channels and scales them with a zero value of 0⁰ F and 100⁰ F per segment. Each 100⁰ above the zero value enables one additional segment. Since the bottom segment is always displayed, the bar graphs do not change until the channel reaches 200⁰. At 200⁰ the second segment turns on. At 300⁰ the third segment is enabled.

The zero and step values may be changed in Setup mode, where they are identified as Lo and inc respectively. The default setup uses the same Lo and inc values for all bar graphs. If the unit has the Individually Programmable Bar Graphs option set, the bar graphs may be scaled individually. This option also allows the user to modify the channel assignments of the bar graphs. See Master Clear on page 22.

The Buttons

The ProTune has a single row of water-proof buttons. The top row of labels gives the function of each button in Run mode. The bottom labels are used in VCR mode.

The Warning Light Option

Systems shipped with the warning light option provide a 1 Amp relay connection. If any channel is over-limit, the ProTune closes the relay. The warning relay is also flashed with the LCD on power-up.

Run Mode

Overview

Run Mode is the normal operating state of the ProTune. The unit updates the currently selected User Display and the four bar graphs while waiting for button presses from the user.

The function of each of the buttons is described below:

ON/OFF
The ProTune powers up in Run mode when the ON/OFF switch is pressed. When power is first applied, the display is set to User Display 0, the distance traveled is zeroed, all snapshots are cleared, and the tape is loaded with a sample 660' drag run.

DISPLAY
Pressing the Display button cycles the LCD to the next User Display. The channels shown on the screen change to those defined in Setup mode for the selected User Display.

STORE
The ProTune maintains three frames of snapshot memory. Pressing the Store button copies the current readings from all channels into the next available snapshot. After all three snapshots have been taken any further STORE presses are ignored.

The ProTune may be set to store the most recent three STORE presses rather than the first three frames stored. See Master Clear on page 22.

The STORE button may be connected to an optional remote switch so that the driver of a sled may more easily store readings for later review. See Configuring the Optional Remote Switch on page 32.

RECALL
Pressing Recall displays the Max Snapshot frame. This frame displays the highest reading from each channel since the Clear button was last pressed. Each subsequent press of the Recall button displays the next oldest snapshot.

If the Timer has been enabled, the fourth and each subsequent RECALL press displays one of up to sixteen elapsed times.

When viewing snapshots, the left-hand units indicators flash the letter "M" and the number of the currently viewed snapshot to alert the user that he is looking at stored data. Note that while snapshot memory is selected, the Display button functions normally. This feature allows the user to view each channel of each frame of memory as if he was viewing real-time data.

CLEAR   If any channel is in overlimit, pressing CLEAR acknowledges the condition and restores the display to normal. If no channels are in overlimit, pressing the Clear button erases all frames of snapshot memory, clears the stored elapsed times, zeros the distance traveled, and resets the Max Snapshot.

Clearing a channel lasts only until it drops below the warning limit. If a channel drops into range and then rises back out of limit it must be re-Cleared to return the display to normal.

BKLIGHT   Pressing BKLIGHT turns the optional LCD backlight on and off. The internal battery will not run the backlight.

Note that if the internal temperature of the ProTune falls below -10°F, the software will turn the backlight on to keep the LCD warm.

SETUP   The Setup button causes the ProTune to enter Setup mode. See the chapter on Setup for a full description of that mode.

PLAYBK   The PlayBk button puts the CSI 400 ProTune into VCR mode, cancels the Record mode, and resets the VCR tape to the first frame.

Using Run Mode

Changing the Current Display Mode

The User Displays are numbered d0 through d9. On power-up the unit shows d0, which is factory preset to RPM 1 and MAX EGT. To see other channels, press DISPLAY until the desired data is shown. If the desired channels are not shown on any User Display, see the chapter on Setup Mode to add them.

Snapshots

The ProTune has memory for four separate snapshots of data. One of these snapshots is used by the system to capture the peak reading from each channel. Run mode continuously updates this maximum memory. Each of the remaining three user snapshots holds the value of every channel at the moment the snapshot was stored.

To take a snapshot of data, press STORE. If the optional remote switch is configured as the STORE button, it may also be used to store a snapshot of data.

To view the maximum snapshot, press RECALL. The left-hand units indicators alternate ^{MX} with the indicators appropriate to the display mode. Pressing DISPLAY allows the user to change display modes to view the maximum reading from each of the channels.

To view the stored user snapshots, press RECALL while viewing the maximum snapshot. The ProTune alternates ^{M1} with the left-hand indicators while the first user snapshot is displayed.

Pressing RECALL again changes the view to the second user snapshot and flashes ^{M2} on the left-hand display.

The next press of RECALL shows the third snapshot and ^{M3}.

Pressing RECALL while the third snapshot is displayed shows the stored Timer values. If the Timer is not enabled or there are no stored times, RECALL returns the unit to Run mode.

Timers

The Timer option allows the user to store elapsed or accumulated times. The most recent of these times is shown by the ^{TIM} display mode. The stored times are displayed, from oldest to most recent, after the user snapshots. Each press of the RECALL button shows the next most recent time. Up to 16 times may be stored and recalled.

Setup offers two different modes for the timer, "inc" and "Acc". Inc, or incremental, mode displays the time between the two most recent pulses. Acc, or accumulative, mode shows the time between the first pulse and the most recent pulse. Both modes discard the first pulse, using it only to start the timer. (The value the first pulse displays in Run mode is the elapsed time since the unit was powered on.)

For example, if four pulses occurred at 1 second intervals, inc would display .01 : 000 (1 second) for each of the three valid pulses. Acc mode would display .01 : 000 for the first valid pulse, .02 : 000 for the second, and .03 : 000 for the third.

Clearing Data

All snapshots, timers, and the distance traveled may be reset by pressing CLEAR. If any channel is in unacknowledged overlimit, CLEAR acknowledges the alarm *without resetting memory*. Press CLEAR once to acknowledge the alarms and again to clear the data.

VCR Mode

Overview

VCR mode uses the bottom row of button labels. It is entered by pressing the PlayBk button while in Run mode. The LCD indicates VCR mode by enabling the small box near the top center of the display. Note that, in VCR mode, the buttons behave very much like the similarly named buttons on a VCR.

RECORD   The Record button rewinds the tape to the beginning, switches to Run mode, and starts recording. A small arrow blinks in the top center of the screen until the unit runs out of tape (about 25 seconds).

                      Record stores five frames of data per second onto the tape. The temperature and analog channels are compressed as they are stored. Some rounding of these channels during playback is normal.

                      The record function can also be accessed by activating the optional remote switch. See inP in the Setup manual.

                      Note: **There is no real tape**. Data is actually stored to solid-state computer chips.

DISPLAY   This button acts the same as in Run mode except that the data displayed is from the tape rather than being real-time data from the sensors.

REWIND   Rewind sets the tape back to the first frame.

PLAY   The Play button replays the recorded data from the current frame to the end of the tape. While the data is playing from the tape the arrow indicator flashes in the box indicator.

STEP $\Leftarrow$ This button displays the previous frame from the tape.

STEP $\Rightarrow$ This button displays the next frame on the tape.

STOP   Stop ceases playback of the tape and displays the current frame.

RUN   Pressing the Run button exits VCR mode and enters Run mode.

Using VCR Mode

Entering VCR Mode

To enter VCR mode from Run mode press PLAYBK. The VCR mode indicator box lights, recording stops, the tape rewinds, and the first frame of tape is displayed.

To leave VCR mode, Press PLAYBK again.

Note that since the lower row of labels is used to name the buttons in VCR mode, the ON/OFF button is interpreted as RECORD. To turn the unit off press PLAYBK and then ON/OFF.

Recording a Run

To record a run, enter VCR mode and press RECORD. The ProTune reverts to Run mode and blinks the arrow indicator in the top center of the LCD for 25 seconds. When the tape ends, the arrow stops flashing and the unit remains in Run mode.

While the arrow blinks, all channels except the optional RPM3 are recorded to the tape. RPM 1 and RPM 2 are stored at five samples per second. On the basic unit the EGT channels are also stored at five samples per second. If any of the optional Analog channels are installed they alternate storage with the EGTs, slowing the data rate to 2.5 samples per second. RPM 3 shows 0 while in VCR mode.

Note that VCR mode's RECORD button is Run mode's ON/OFF button. Trying to start a recording while in Run mode simply switches the unit off.

Playing a Recording

Once the run is complete, re-enter VCR mode by pressing PLAYBK. The display shows the first frame of the recorded data.

Press PLAY to replay the tape. The arrow blinks within the VCR mode box to indicate that the tape is playing. DISPLAY functions normally to step through the User Displays.

To stop the tape, press STOP. The tape stops and displays the current frame. To restart the tape, press PLAY.

To reset the tape to the beginning, stop the tape and press REWIND.

Tape Counter

Display type $^{TIM\,2}$ shows the number of seconds from the start of the tape to the current frame.

Examining Individual Frames

When the tape is stopped, the STEP $\Leftarrow$ and STEP $\Rightarrow$ buttons move the tape one frame forward or back. To restart the tape, press PLAY.

Special Features

Over-limit Alarms

The ProTune allows the user to place limits on each of the standard input channels, as well as on the optional Analog and extra EGT channels. The factory presets the RPM and temperature limits to 10,000 RPM and 1450° F. The warning levels of the optional Analog channels are preset to the sensor's maximum or to 5.00 Volts.

In Run mode, if the reading from any channel exceeds its limit the ProTune overrides the current User Display and flashs the over-limit channels on the screen. RPM 1 forces itself onto the left-hand display; all other channels override the right-hand display. If more than one channel is in overlimit, each channel flashes in turn.

The user may acknowledge an overlimit condition by pressing CLEAR. Once an overlimit channel has been acknowledged it will no longer override the display, although it will still flash if selected normally. The optional warning light relay and any bar graph assigned to an overlimit channel will also flash, even after CLEAR is pressed.

Note that pressing CLEAR to acknowledge out of range channels does **not** perform the normal Clear function. Stored memories, distance traveled, and timers are retained if any channels are unacknowledged and out-of limit when CLEAR is pressed.

Acknowledging an overlimit channel lasts only for the duration of the overlimit period. If a channel drops below the warning threshold and then rises back into alarm, the condition is a new, unacknowledged overlimit.

Cold Weather Operation

As the temperature of the ProTune's LCD falls, the response time of the display slows. To compensate, the ProTune updates the display less frequently as the temperature drops. The sampling rate and Playback mode are unaffected.

When the ProTune detects a low internal temperature, it attempts to warm the LCD by switching on the backlight. The basic unit, which has no backlight, is equipped with a resistive heater to provide the unit a means to warm itself. Using the backlight or internal heater, the ProTune is capable of maintaining an internal temperature about 30° F higher than its surroundings. During the approximately 20 minutes it takes to warm up, the ProTune adjusts the display rate to match the capabilities of the LCD. Once it has warmed up the unit should operate normally at temperatures well below -40º F.

Both the backlight and the resistive heater require an external power source; neither will run on the optional internal battery.

The table below summarizes the cold-weather behavior of the CSI 400 ProTune:

Internal Temperature	Effect
Below -10° F	Backlight (or resistive heater) turns on to warm LCD.
Above -20° F	Display update rate normal at 5 per second.
-20 to -30° F	Display update rate slows to 2.5 per second.
-30 to -40° F	Display update rate slows to 1 per second.
Below -40° F	Display update rate slows to 1 per 3 seconds.

Master Clear

Holding the CLEAR button down while powering on the unit resets all user-configurable options to the factory presets. With the power turned off, hold CLEAR and ON/OFF until the LCD stops flashing. The display shows the software revision level of the ProTune unit and the unit sets permanent memory to the factory defaults.

Master Clear should be used carefully.

Advanced Setup

Holding the SETUP button while powering up allows the user to modify several seldom-changed options:

bAr OnE	The bAr option determines how the bar graphs behave. bAr ALL sets all four graphs to the same scaling and uses them to display the EGTs. bAr OnE allows the user to individually scale the graphs and to assign each to a separate channel. (See The Bar Graphs on page 13.)
M 123X Lo OFF	This option determines what the unit does when the STORE button is pressed for the fourth time. If Lo is set to On, the ProTune stores the first three snapshots and ignores all subsequent STORE presses. With Lo set to OFF, the most recent three snapshots are stored; Lo OFF stores the fourth snapshot by discarding the first.

Errors and Glitches

The snowmobile's environment is extremely hostile to electronics. Although the RacePak ProTune has been carefully engineered to withstand the rigors of the sport, errors may eventually occur.

The ProTune has two lines of defense against upsets that reach the microprocessor and memory. The first of these defenses catches errors that misdirect the microprocessor. In the unlikely event that the computer or its working memory become scrambled, the ProTune will turn the computer off and then on again. This reset leaves the ProTune in the same state as when it is initially turned on, causing the LCD to flash and the display to revert to User Display d0.

The second defense warns about corruption of the permanent memory. Every time Setup mode completes, it writes a verification stamp into permanent memory. Each time that the ProTune is switched on it checks that stamp against the memory itself. If the memory does not match the stamp, the ProTune flashes "cFg Err" on the display and waits for a button press. Once a button is pressed the unit enters Run mode and operates normally, *but with a possibly incorrect setup.*

If the "cFg Err" message is displayed at power-up, verify and correct the Setup information as soon as possible. The unit will continue to power up in "cFg Err" mode until Setup is checked.

Incorrect Setup information may result in erroneous readings.

Configuration (Setup mode)

<u>Overview</u>

This chapter provides a description of the Setup mode of the CSI 400 ProTune data logger. Setup mode is entered by pressing the Setup button while the logger is in Run mode.

Notice
Some Setup screens modify settings for optional equipment and do not appear on the basic unit. These entries are printed on the dark background used for this paragraph.

The Setup screens use the buttons as follows, unless otherwise noted.

STEP $\Leftarrow$ Press this button to decrease the selected number.

STEP $\Rightarrow$ Press this button to increase the selected number.

SETUP   This button accepts the current value and proceeds to the next value or step.

PLAYBK   Pressing PlayBk ends the Setup session, saves all entries into permanent memory, and returns the ProTune to Run mode.

The Setup mode entries are:

1 RPM

P1   ?   Enter the number of pulses per revolution for RPM channel 1. Specify 0 pulses per revolution to indicate one pulse per two revolutions.

Optional extra (jack shaft) RPM channel		
2 RPM		
P2 ?	Sets the number of pulses per revolution for channel 2.	
RAT		
FAc ?.??	Sets the factor to be applied to the ratio of RPM1 to RPM2. The ratio is calculated $RPM1 \div (RPM2 \times FAc^{RAT})$. See page 29.	

<table>
<tr><td colspan="4">Optional RPM3 channel</td></tr>
</table>

3 RPM

P3	?	Sets the number of pulses per revolution for channel 3, if RPM channel 3 is not being used as a timer. See TIM below.

<table>
<tr><td colspan="4">Optional Timer for RPM3</td></tr>
</table>

TIM

OFF		uses RPM 3 as an RPM. See Timers on page 17.

TIM
On	inc	uses RPM channel 3 as an elapsed time channel. Each pulse causes the unit to store and display the time since the <u>most recent</u> pulse.

TIM
On	Acc	uses RPM channel 3 as an accumulative timer channel. Each pulse causes the unit to store and display the time since the <u>first</u> pulse.

RPM/10

L1	????	Sets the warning limit for RPM 1 in tens of RPM. Ex: Setting this number to 990 causes RPM channel 1 to go into over-limit alarm when it exceeds 9900 RPM.

EGT 1

L2	????	Sets the warning limit for temperature channel 1 in degrees F.

EGT 2

L3	????	Sets the warning limit for temperature channel 2 in degrees F.

EGT 3

L4	????	Sets the warning limit for temperature channel 3 in degrees F.

EGT 4

L5	????	Sets the warning limit for temperature channel 4 in degrees F.

<table>
<tr><td colspan="3">Optional Analog channel 1</td></tr>
</table>

1

L6	?.??	Sets the warning limit for analog channel 1.

<table>
<tr><td colspan="3">Optional Analog channel 2</td></tr>
</table>

2

L7	?.??	Sets the warning limit for analog channel 2.

<table>
<tr><td colspan="3">Optional Analog channel 3</td></tr>
</table>

3

L8	?.??	Sets the warning limit for analog channel 3.

	4	
L9	?.??	Sets the warning limit for analog channel 4.

The next group of Setup options configures the User Displays. These Displays control which channels the unit shows. They are factory preset and need not be changed to operate the unit. To skip to the next section of Setup, press PLAYBK.

1 RPM   MAX EGT

d0   1 6   This is the factory default for the first User Display. "d0" identifies the User Display to be configured. "1 6" indicates that display mode 1 (^{1} ^{RPM}) will be used for the left-hand value and display mode 6 (^{MAX} ^{EGT}) will be used for the right-hand value.

Press the STEP buttons to change the flashing display mode. The units labels change to track the currently selected mode.

Press the SETUP button to accept the current display mode and modify the next one. PLAYBK skips past the rest of the User Displays, but does not exit the SETUP mode.

Note: Some values can not be displayed in some positions. See User Displays on page 31 for a complete listing of available options.

After all User Display modifications are completed, Setup continues with configuration screens for the bar graphs. If the bar graphs are configured as a group, Setup displays all 4 bar graphs at once and requests Lo and then inc in degrees Fahrenheit:

EGT 1234

Lo   ???   Sets the value represented by the lowest line of each bar graph in degrees F.

EGT 1234

inc   ???   Sets the number of degrees F that each segment of each bar graph represents.

<table>
<tr><td colspan="3">Individually User-Programmable Bar Graphs</td></tr>
</table>

Individually User-Programmable Bar Graphs

If the bar graphs are set to be user-reconfigurable (See Configuring Bar Graphs on page 30), Setup gives an opportunity to set each graph to its own channel:

EGT 1

bAr	1	Sets bar graph 1 to the channel whose units indicators are displayed.
bAr	2	Sets bar graph 2 to the channel whose units indicators are displayed.
bAr	3	Sets bar graph 3 to the channel whose units indicators are displayed.
bAr	4	Sets bar graph 4 to the channel whose units indicators are displayed.

Setup then displays each bar graph in turn and requests to following information:

EGT 1

Lo	????	Sets the value represented by the lowest line of the bar graph in appropriate units. The units are RPM/10, degrees F, Volts, and MPH.

EGT 1

inc	????	Sets the number of units that each segment of the bar graph represents.

TIM

OFF	??	Sets the number of minutes that the ProTune waits to turn itself off to conserve battery power. The ProTune turns itself off if external power is not present and there have been no button presses within the time limit set here. Setting OFF TIM to 0 causes the ProTune to stay on indefinitely.

inP   inP determines how the ProTune interprets closure of the optional remote switch.

M X 123

inP	SAv	causes the unit to treat switch closures as presses of the STORE key.

<record box and arrow>

inP	rEc	tells the unit to begin or restart the Record function of VCR mode each time the switch is closed.

Optional extra (jack shaft) RPM channel

<small>MPH</small>

CAL ????   The final entry in Setup mode is the number of RPM pulses per eighth mile of sled travel. This number is required to properly calculate miles per hour. The STEP buttons work normally to directly modify the value displayed.

Alternatively, the operator may press RECORD and simply drive the sled 660 feet (one eighth of a mile). The ProTune will record each RPM pulse as it occurs and set the number automatically. Once the sled has been driven one eighth of a mile, press SETUP to save the number of pulses and return to Run mode.

Note that any tread slip while driving the calibration run will induce error in all MPH and distance traveled calculations.

Using Setup Mode

Configuring RPMs

The ProTune reads the fluctuations in the lighting coil to determine RPM. Since not all sleds produce the same number of pulses per engine revolution, that constant must be programmed into the unit. The number of pulses per revolution generated by any sensor attached to the optional RPM channels must also be entered into the unit.

The ProTune can accomodate ignition systems and sensors providing from one to twenty pulses per revolution.

Calibrating RPM 2 Pulses per Mile

The optional RPM 2 channel can be used by the ProTune to determine miles per hour and distance traveled. In order to convert RPM data into distance (and then to speed), the unit must know how many feet of travel each pulse represents. The ProTune stores this information by recording the number of pulses in one eighth of a mile (660 feet).

The CAL ^{MPH} Setup entry provides two methods of entering this value. The most direct way of setting the constant is to use the STEP buttons.

A faster method is to drive a 660' straight course with the unit counting pulses. Pressing RECORD rather than the STEP keys tells the unit to count all the pulses that occur. After driving the 660' press SETUP. The ProTune stores the number of pulses and returns to Run mode.

Note that only one of these methods may be used at a time. If the RECORD button is pressed the STEP buttons will be ignored. Likewise, if a STEP button is pressed, RECORD will have no effect. If fine tuning of the calibration value is required, re-enter Setup and modify the calibration value using the STEP buttons.

Setting the RPM 2 Ratio Factor

The ^{RAT} display type shows the scaled ratio of RPM 1 to the optional RPM 2. This number is scaled by multiplying RPM 2 by the FAc ^{RAT} value entered in Setup. The formula is

$$RPM1 \div (RPM2 \times [FAc ^{RAT}])$$

FAc ^{RAT} is used to account for the gear reduction from the engine to the input of the clutch. If this value is set to the gear reduction ratio the ^{RAT} display type will read 1.00 when the clutch is locked.

As an example, assume that the gear reduction ratio is 1.25:1. If the engine is spinning at 12500 RPM, the input to the clutch spins at 10000 RPM. If the clutch is locked, the drive shaft is turning at 10000 RPM also so RPM 2 will be 10000 RPM. RAT will show 12500÷(10000×1.25), which equals 1.

Configuring the Timer

The Timer requires the optional third RPM channel. If the Timer is configured to On, then RPM 3 may not be used.

See Timers on page 17 for a detailed description of the Timer modes.

Configuring Temperatures

Each temperature channel has a warning limit that may be set in Setup mode. Use the STEP buttons to determine the warning level, in degrees Fahrenheit, for each EGT channel.

See Over-limit Alarms on page 21 for a description of the alarm system.

Configuring Bar Graphs

The ProTune has two variables the user may set to modify the behavior each bar graph. The first of these, Lo, determines the value of the lowest segment of the graph. By default, Lo is set to 0^0 F.

The second configuration option is "inc", or increment. Increment determines how many degrees each segment above the first represents. The factory preset for inc is 100^0 F.

See The Bar Graphs on page 13 for a more detailed description of the bar graphs.

As shipped, the unit displays the four EGTs on the bar graphs and assigns the same scaling to each. The ProTune can be set to allow the user to individually assign each bar graph to its own channel and its own scaling. For example, the user could assign graph 4 to show RPM 1 starting at 5000 RPM with 500 RPM per additional segment.

Setting the Individually Programmable Bar Graphs option requires that the user decide which channel each bar graph will display. He must also set Lo and inc for each bar graph separately, rather than using the same values for all four graphs.

Configuring Analog Inputs

Each of the four optional Analog inputs has a limit level. The units on the limits vary by sensor type.

Configuring User Displays

Display Modes

Data is presented and identified using User Displays, each of which consists of a left- and right-hand display mode. A display mode defines how the ProTune uses one of the numeric displays.

User Displays

The User Displays are the only means by which the ProTune shows numeric data. The ten User Displays are identified as "d0" through "d9" and consist of one display mode for each of the two numeric displays. The number on the left shows the display mode for the left-hand numeric display. The number on the right shows the mode for the right-hand display. A display mode of 0 means that the display remains blank. Any User Display set to "0 0" is skipped when the user presses DISPLAY.

There are restrictions on which channel can be displayed on each side of the LCD. Channels which cannot be displayed are skipped when setting display modes. All valid display modes are listed in the table below. The left-most column shows the units labels that Setup uses to identify the display mode as well as the largest number that mode can display. The next columns indicate whether the display mode is available in the left-hand display, the right-hand display, or either display.

RPM 1 x10			
1999	L		RPM 1 in RPM / 10.
RPM 2 x10			
1999	L		RPM 2 in RPM / 10.
RPM 3 x10			
1999	L		RPM 3 in RPM / 10. Becomes ^{TIM} 3 if Timer set to "inc" or "Acc".
MPH			
1999	L	R	Miles per hour as calculated from RPM 2 and CAL ^{MPH}.
M			
1999	L		Total miles traveled since power-on or last CLEAR. Calculated from RPM 2 and CAL ^{MPH}. Run mode only. This display type becomes ^{X} in VCR mode.
X			
1999	L		Total feet traveled since start of tape. Calculated from RPM 2 and CAL ^{MPH}. VCR mode only. This display type becomes ^{M} in Run mode.
RAT			
9.99		R	Ratio of RPM 1 divided by RPM 2.
M EGT n			
1999		R	Maximum EGT channel in degrees F. The number of the highest channel is displayed as a unit label.
EGT 1-3			
1999	L	R	EGT channels 1 through 3 may be shown on either numeric display.
EGT 4			
1999		R	EGT channel 4 may be displayed only on the right-hand display.
1-3			
5.00	L	R	Analog channels 1 through 3 may be shown on either numeric display.
4			
5.00		R	Analog channel 4 may be displayed only on the right-hand display.
TIM 2			
24.8	L		Time index in 0.2 second increments since the start of the VCR tape.
TIM			

19.59 : 999   L **and** R   Elapsed time in thousandths of a second. Available only if RPM 3 is used as a timer.

^{TIM 3}
199.9   L   Elapsed time in tenths of a second. Available only if RPM 3 is used as a timer. Becomes $^{RPM\,3}$ if timer set to OFF.

<u>Configuring the Optional Remote Switch</u>

The optional remote switch may be user-configured to either take a snapshot of data or to start recording data to the VCR tape. When the switch is configured to $^{M\,123X}$ SAV it behaves like a STORE button press. Configured as rEc, it starts recording data from the beginning of the VCR tape.

Factory Presets (Defaults)

All of the ProTune's user-configurable settings are preset at the factory to be as nearly ready to use as possible. The unit can be returned to the defaults by performing a *master clear*. (See Master Clear on page 22.)

The factory defaults for the basic unit are:

P1	1	Pulses per engine revolution.
L1	10000	RPM warning limit.
L2	1450	Degrees Fahrenheit warning limit for EGT 1.
L3	1450	Degrees Fahrenheit warning limit for EGT 2.
L4	1450	Degrees Fahrenheit warning limit for EGT 3.
L5	1450	Degrees Fahrenheit warning limit for EGT 4.
L9	5.00	Volts warning level for internal temperature sensor.

			Left Display	Right Display
d0	1	6	RPM 1	MAX EGT
d1-3	0	0	Skipped	Skipped
d4	7	8	EGT 1	EGT 2
d5	9	A	EGT 3	EGT 4
d6	0	0	Skipped	Skipped
d7	0	H	Blank	Internal temperature sensor voltage
d8	H	0	Elapsed time	Blank
d9	0	0	Skipped	Skipped

Lo	0	Bar graph zero is 0 degrees F.
inc	100	Bar graph increment is 100 degrees F.
OFF	10	Idle minutes to auto-shutoff without external power.
inP	SAv	Optional remote switch stores snapshot.

Optional Equipment

EGT 3 and 4

These options provide additional channels of temperature information. Each channel of temperature input has a separate overlimit alarm.

RPM 2 (Jack Shaft)

RPM 2 provides a second channel of RPM information which can be used to determine several other calculated values.

Miles per Hour

Determined by reading RPM 2.

Miles Traveled

Determined by reading RPM 2.

Feet Traveled (VCR mode)

Determined by reading RPM 2.

Ratio

Determined by reading RPMs 1 and 2.

RPM 3 Channel

The third RPM input channel provides a general purpose RPM. Unavailable when using the optional Timer.

Timer

The Timer channel stores the elapsed time between external pulses and allows the user to view incremental or accumulated times.

Analog Channels

The optional Analog channels provide alarmable data from a wide variety of sensors. The Analog channels can be factory-scaled to to a variety of units:

Quantity	Range	Units	Comments
Voltage	0.00 to 5.00	Volts	
Temperature	-99 to 1999	° F	
Pressure	0.0 to 60.0	PSI	
Pressure	0 to 200	PSI	
Acceleration	-2.5 to 2.50	Gs	
Differential Pressure	-60 to 60.0	PSI	Displays pressure at Analog 1 minus pressure at Analog 2.

Glossary of Terms

Channel   The connection between a *sensor* and the computer.

EGT   Exhaust Gas Temperature.

Factory Default As it was when it left the factory.

Factory Preset Same as *Factory Default*.

Frame   A *snapshot* consisting of one reading from each data *channel*. Used also to refer to one frame of the *VCR mode tape*.

Master Clear Clears all user-settable options to the factory defaults. Performed by holding the CLEAR button on power-up until the display stops flashing.

Max Snapshot A data *frame* consisting of the maximum reading from each channel.

Real-time   Happening now. Real-time is the opposite of "stored." Monday night football is mostly real-time. The instant replays are not real-time.

Run Mode An operating mode of the CSI 400 PT that displays *real-time* data and stored snapshots.

Sensor   A device that measures some quantity (e.g.: temperature) and passes the measurements to the computer along a *channel*.

Snapshot   Same as *Frame*. Used to distinguish stored data from frames of VCR *tape*.

Tape   The memory and stored data *frames* of *VCR mode*. The tape consists of 25 seconds of stored frames which can be manipulated in VCR mode.

VCR Mode An operating mode of the CSI 400 PT used for storing and manipulating a 25 second stream of stored data *frames*. Named for the device its controls resemble.

Index

Appendix A: Installation Guide

The following pages contain drawings of the cables and mounting brackets used to install the ProTune on your sled. We have included the drawings for all optional equipment, as well as for the basic unit. Use the drawings that most closely match your ProTune unit.